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SOME EXPERIMENTS ON ANIMALS INVOLVING CONNECTION
AND TRANSPLANTATION OF BLOOD VESSELS

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Starting from experiments which were to determine on a preliminary basis how a vein behaves with the blood pressure of an artery, further experimentation concerned the transplantation and implantation of vessels. I shall briefly describe them although the results can be characterized as negative with respect to their usefulness in surgery.

The first experiments involved my placing on four dogs a connection between the central terminus of carotis communis and the peripheral terminus of vena jugularis externa. I always connected the vessels end to end according to the method described by Pary*** using magnesium cannulas.

The four abovementioned animals withstood the attack quite well and the wounds healed without reaction. With the sectioning of the animals which was undertaken two to six weeks following the operation, there was found a complete obliteration of the carotis communis and the vein connected with it onto their smallest branches.

I carried out six further experiments during which I laid open both the carotis as well as the jugularis externa of the animals for a rather large length and thereupon separated the carotis at half-height of the neck. The vein, however, was cut through in the jugulum and at the height of the larynx. Then, the central carotis terminus was connected with the central terminus of the separated portion of the jugularis externa and the peripheral terminus of this portion was connected with the peripheral carotis terminus so that now the arterial blood flowed through the carotis up through the vena jugularis externa and then again through the carotis. All experiments reported by me were carried out with aseptic precautions, and I checked each time after performance of the anastomosis concerning their mobility by palpating the vessels. After ending the operation, I was regularly able to ascertain pulsation of the veins and arteries located peripheral to them. As in the four first mentioned experiments, the heavy swelling of the veins now under arterial pressure was conspicuous. The section of the animals was performed from five days to two months after the operation. The constant finding was thrombosis of the heavily swollen veins in the vessels investigated shortly after the operation. Later, this was also true of the carotis in its delivery and removal function. The conditions five days after the operation are best illustrated by the figure below.

* Numbers in the right margin indicate pagination in the original text.

** Wiener Klinische Wochenschrift, 1903, pp. 273-274, No. 10.

***Archiv f. klin. Chirurgie, 1900, Vol. 62, No. 1.



In the case of a, the carotis delivering can be seen whereas in b we have the removing part of the carotis. The vein whose largest part is filled by the thrombus is located between the two of them at c. Points d and e, which were prevented from expanding by the magnesium cannulas, were kept free from the thrombus. The figure shows quite well the connecting point of artery and vein between d and a.

The constant presence of a thrombus in the vein standing under arterial blood pressure suggests that this is conditioned by the elongation of the thin wall. Further, it is affected by mechanical lesion, nutritional disturbances and such like or through the effect of arterial blood on the intima of the vein whereby the latter acts as

a foreign body with respect to the first one.

In order to check this assumption, I took two dogs and made a connection of the central carotis terminus with the central end of the jugularis externa so that the carotis blood returned directly to the heart. Narrow magnesium cannulas were selected for forming the anastomoses. In the one case, only an approximately pin-thick bloodstream flowed into the vein. After completing the operation, I became convinced that the vein was not expanded and that so little blood flowed into it that it collapsed with each diastole of the heart. In the case of the section which I undertook 16 days later, I was able to see that the blood flow passed the point of the anastomosis and that no thrombosis had taken place. In the second case, I used a cannula with a larger aperture. With the autopsy which took place six days later, thrombosis was found of the rather expanded vein and the delivering carotis. Since no thrombosis appeared using a narrow cannula, in a further experiment I prepared a connection of the central carotis terminus with the peripheral terminus of the jugularis externa using a cannula with only a 2 mm aperture. After the operation, the vein was not so greatly expanded as in the case of using further cannulas. Still, I also found here after six days a thrombus in the delivering carotis and in the peripheral vein with its branchings.

In those experiments where the vein underwent the pressure of the carotis communis, I saw uniformly when sectioning the animals serous saturation of the tissue around the point of operation. The musculature revealed a gelatinous consistency which is a proof that the vein wall was under arterial pressure and allowed plasma to pass through.

The abovementioned experiments revealed that veins under the influence of arterial blood can certainly exist but tend to develop thromboses so that the thought of replacing a lost artery by a neighboring vein has no practical significance.

These findings of my experiments generally check well with experiments by Vignolo* who generated experimentally on dogs an arteriovenous aneurysm

*Il Policlinico, 1902, Vol. IX. C. fasc. 5, p. 197.

between the carotis and jugularis externa or between arteria and vena femoralis.

He operated in such a manner that he opened the lumens of the vessels by excision of an elliptical portion and then sutured the borders of both breaks in the vessel. The author emphasized the trend to spontaneous healing of these aneurysms either by the increase of anastomosis or by thrombosis in the peripheral vein section. The latter event was regularly observed in the femoralis. Similar results were achieved by San Martin y Satrustegni* who performed an anastomosis between carotis and jugularis on goats. With the section, the author found thrombosis of the vein and closure of the opening.

It is clear from these experimental results that tests such as made by San Martin y Satrustegni** led in two cases to gangrena senilis of the lower extremities and aided the sick animal in no way. He established namely in both cases an anastomosis between arteria and vena femoralis. In one case, the anastomosis did not function right after the operation whereas in the other case a judgment of the function was not possible. Gangrene occurred in both cases. Jaboulay, who likewise wished to establish in a similar case an anastomosis between the abovementioned vessels, proposed in such cases to set up an anastomosis between arteria and vena iliaca and then further between carotis and jugularis. All of these therapeutic experiments failed owing to the fact that, as shown uniformly by the animal experiments, a thrombosis of the vein appears after the establishment of a connection between artery and vein. (Exceptions are given in a number of cases reported by Vignolo where the connecting opening closed by itself and, further, in one of my experiments.) Thus, the operation which is always carried out for the removal of an impediment to passage in the artery would only have as a consequence a damage such as thrombosis of the vein.

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Subsequently, it was suggested to undertake vessel transplantations following the experiments described above. Taking two dogs, I laid open on both sides the vena jugularis externa and implanted in it an approximately 4 cm long portion of vein from the one side into a similarly large defect on the other side by means of two magnesium cannulas. After completion of the operation, I was able to see that circulation took place through the implanted vessel. With the section, which took place six and eight days later, the wounds showed no reaction. The implanted vessels were in both cases filled with a thrombus and the neighboring parts of the vein remaining in situ were thrombosed.

I undertook transplantations with two other dogs. With one of them, in a similar way, a 4 cm long defect of one carotis was replaced by a similarly long portion of the other carotis. Six days later when the section was made, I found thrombosis of the implanted arterial portion and the central carotis remaining in situ. In the case of the second animal, a portion of one arteria femoralis was transplanted into a defect of the other side. One week later, I likewise found thrombosis.

* Chirugia des aparato circulatorio Madrid, 1902, quoted according to Semaine Medicale, 1902, p. 395.

**Loc. cit.

The cause of the failure of the transplantation experiments can certainly be chiefly attributed to the lacking nourishment of the vessels. Since the vasa vasorum entities as a rule branch off and return from one branch of the stem to be supplied, the nourishing vessel of the transplanted artery or vein is placed out of operation. This conditions a nutritional disturbance of the vessels whose consequence is thrombosis. It becomes clear from this that the blood flow within these large vessels is not sufficient for their nourishment.